

## Effect of Dietary Habit and Physical Activity on Over Nutrition of School Going Adolescents

**Bhagraj Choudhary**

Assistant Professor, Department of Community Medicine, Netaji Subhas Medical College and Hospital, Amhara, Bihar, Patna, Bihar, India

Received: 09-05-2021 / Revised: 22-06-2021 / Accepted: 29-07-2021

Corresponding author: Dr. Bhagraj Choudhary

Conflict of interest: Nil

### **Abstract**

**Aim:** To estimate and compare the effects of different dietary habits and habits related to physical activity in the development of overweight and obesity among rural school going adolescents. **Methods:** The prospective cross-sectional study which was carried in the Department of Community Medicine, Netaji Subhas Medical College and Hospital, Amhara, Patna, Bihar, India for 12 months. A prospective follow-up study was conducted among adolescents (14–18 years) studying at secondary and higher-secondary level (Classes IX to XII) in four selected school. The participants, who were permanent residents of the rural areas, were surveyed at the beginning, and a follow-up assessment was done after 6 months. Thus, two repeated measures were taken on each individual participant. A total of 200 participants (80 male and 120 female respondents) were ultimately included in this study. **Results:** Among the dietary habits, the students reported that 12% went hungry most of the times, 50% were eating fruits less than once a day, and 25% were eating vegetables less than once a day. Regarding frequent intake of soft drinks and fast foods, the prevalence was 46% and 54%, respectively, at the time of initiation. However, on follow-up visit, all the prevalence were seen to be higher except frequent intake of junk foods, which fell down to 50%. Infrequent intake of vegetables was prevalent among 30% of the participants on follow-up. Now, this difference was statistically significant. While the prevalence of unhealthy dietary habits overall was noted to be 70% at the baseline, there was a marginal decrease to 68%. However, this difference also was not significant statistically. Risk factors pertaining to physical activity among adolescents, for example, usually not walking or cycling to school increased to 33% on follow-up compared to 30% at the baseline. However, there was a marginal decrease in prevalence of sitting activities from 15% at the baseline to 14%. Similarly, for inadequate other daily physical work, the prevalence decreased from 25% to 24%. **Conclusion:** Strong evidence was generated of dietary practices being more rigidly related to overweight among the adolescents. Healthy dietary practices coupled with physical activity should be promoted to mitigate the risk of obesity.

**Key words:** Adolescents, diet, nutrition, obesity, overweight, physical activity, risk factors, rural.

This is an Open Access article that uses a fund-ing model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

### **Introduction**

Adolescence marks a period of transition from childhood to adulthood characterized

by rapid physical growth and development, behavioral, emotional, and socio-

psychological changes[1]. Adolescents are more prone to unhealthy behaviors, poor dietary practices and nutritional compromises, physical inactivity and psychosocial stresses that shape their personalities and lifestyle patterns. Rapid physiological changes affect their body's nutritional demands while lifestyles, beliefs and perceptions about body size and shape influence their dietary choices and practices. The nutrient requirements during adolescence are increased due to accelerated growth and development, hormonal, physical and behavioral changes and are often not met due to inappropriate food choices, peer pressure, unhealthy attitudes and lifestyle practices that make adolescents more susceptible to nutritional deficiencies[2]. Good nutrition is essential for preventing nutritional disorders and averting subsequent incidence of acute and chronic diseases in later life[3-5]. Failure to consume a nutritionally balanced diet at this decisive point in life not only arrests linear growth but also influences the psychomotor functioning of adolescents[6]. Numerous studies and reports[7-11] revealed that adolescents are at a greater risk of nutritional deficiencies and disorders due to their rapid body growth, unhealthy eating habits, psychological, mental and emotional pressures associated with body dissatisfaction and temptations to have a slimmer body. Adolescents also tend to suffer from a variety of eating disorders i.e., anorexia nervosa, bulimia nervosa as well as depression, anxiety and psychological stress[12]. In developing countries including India, adolescents' health and nutrition is largely under-researched and has been ignored due to the silent nature of nutritional problems, undocumented evidence of life-threatening epidemics, less assertive attitude of adolescents, muted political interest, and financial constraints. Lack of data on adolescents' nutritional status, dietary practices and physical activities also make it difficult to draw the attention of

Government officials, program managers and policy makers to formulate and develop appropriate adolescent specific strategies for addressing their nutritional and sociopsychological needs. The association between age-specific nutrition and long-term health effects has always been of interest, the current study was designed to compare the nutritional status, dietary practices and physical activities of school going adolescent boys and girls.

### **Material and methods**

The prospective cross-sectional study which was carried in the Department of Community Medicine, Netaji Subhas Medical College and Hospital, Amhara, Patna, Bihar, India for 12 months, after taking the approval of the protocol review committee and institutional ethics committee.

### **Methodology**

A prospective follow-up study was conducted among adolescents (14–18 years) studying at secondary and higher-secondary level (Classes IX to XII) in four selected school. The participants, who were permanent residents of the rural areas, were surveyed at the beginning, and a follow-up assessment was done after 6 months. Thus, two repeated measures were taken on each individual participant. A total of 200 participants (80 male and 120 female respondents) were ultimately included in this study.

### **Study variables and collection**

A predesigned pretested questionnaire was prepared reviewing the GSHS instrument[13] and the WHO-STEPS instrument[14] and comprised of a section on physical activity and another section on dietary habits. There was a question regarding family history as well. Sociodemographic information of the participants was collected during the initial visit. The questionnaire was translated to Bengali and was then back translated to English by two different experts. Validity of the questionnaire was checked by

statistical tests, the discussion of which is beyond the scope of the current article (Cronbach's alpha)[15] was estimated to be 0.82, ensuring good statistical reliability[16]. This instrument was administered among students of a selected section during a single period all at once. Each of them, already allotted an identification number against their roll numbers and name, were then subjected to measurements of height and weight by standardized stadiometer (Indo Surgicals® Height Measuring Scale) and bathroom type weighing machine (MCP® Analog Mechanical Weighing Scale), respectively, following standard protocol. Body mass index (BMI) was calculated as weight (in kilograms)/ height (in meters). The WHO adolescent BMI percentile chart was used to classify the nutritional status of the children[17]. A follow-up visit was done after 6 months to the selected schools, and the same process was repeated on those who were already allotted the identification number from the previous visit.

### Study variables and statistical analysis

Gender of the participants was the only time-invariant predictor of nutritional status. Age of the students, dietary habits, and practices related to physical activity were considered time dependent predictors directly influencing the occurrence of overweight or obesity. Family history of any NCDs or its risk factors (including obesity) was taken as a time-invariant predictor. Those who did not respond to the question were counted to have no family history for the sake of simplicity of analysis. Among dietary habits, episodes of going hungry (i.e., having no food), infrequently eating vegetables or fruits, frequent intake of soft drinks and fast foods were the variables used. Infrequent walking to commute to school, major duration of sitting activities, and infrequent other daily physical work were indicative of physical activity status of the participants. All these variables were measured in terms of a 5-point Likert-type

scale. To arrive at a single variable describing the dietary factors, a principal component analysis was done on the related variables, and single factor with eigen value >1 was taken and then dichotomized into healthy or unhealthy habits. Physical activity variables were also reduced similarly to a single indicative factor.

The variables, both time-varying and time-invariant, were analyzed with the help of population average model or more commonly known as marginal population model – Generalized Estimating Equations (GEEs)[18,19] to find the effect of the predictors with change in time. Robust standard errors were used to achieve an unbiased model fit, especially with respect to outliers. Effect size (epidemiological risk) was estimated in terms of the risk ratio obtained, and the 95% confidence intervals (95% CIs) were reported. *P* value was considered significant at <0.05. The interaction in-between was considered, and the model was compared to GEE model without the interaction terms. Although both the models showed overall fit ( $P \chi^2 < 0.001$ ), model with interaction did not differ from the main model significantly. Next, another model was created with the composite dietary habit and physical activity variables to estimate how much an unhealthy habit overall contributes to the morbidity. In this model, interactions with age and gender were included with the previously mentioned variables. In this case, however, the model with interactions differed significantly from that without interactions. A gender-dependent analysis on these factors was also performed. A statistical invariance of the baseline background information of the students excluded from the analysis was established to maintain sampling integrity and representativeness.

### Results

The mean age of the participants was 16.2 ( $\pm 1.66$ ) years (range: 14–18 years). Most of the respondents (55%) were aged 16

years or below. Among the participants, majority were female (60%), Hindu (78%), and belonging from a nuclear family background (77%). Majority of the participants (55%) were studying in the secondary level (Classes IX and X). Rest of the adolescents were studying at higher secondary level. While 14% of the respondents belonged to Class I of BG Prasad socioeconomic status classification (December, 2016 modification)[20], 32% were from Class IV.

Among those who responded regarding their father's education, majority of the fathers were educated up to higher secondary level (28%). On the contrary, the majority of the mothers had received primary level of education (45%), while 21% were educated up to higher secondary level. While majority students reported that their fathers were involved in farming as occupation (49%), majority of their mothers were homemakers (71%).

The normal nutritional status was observed among 86% of the participants initially; but after 6 months, the proportion was 78%. There was a stark rise in proportion of overweight from 1% to 7% with obesity rising to 2% from previously 1%. Interestingly, the other spectrum of adolescent malnutrition – thinness also increased in prevalence from 12% to 14%, though not as sharp as that of overweight. While girls show an improvement in thinness status over time, boys reported a higher burden of thinness as well. These observed differences were found to be statistically significant as well ( $P < 0.001$ ).

Trend of diet and physical activity related risk factors

Table 1 compares the distribution of the risk factors related to dietary habits, physical activity, and family history of NCDs and risk factors between the two observation points. Among the dietary habits, the students reported that 12% went hungry most of the times, 50% were eating fruits less than once a day, and 25% were eating vegetables less than once a day.

Regarding frequent intake of soft drinks and fast foods, the prevalence was 46% and 54%, respectively, at the time of initiation. However, on follow-up visit, all the prevalence was seen to be higher except frequent intake of junk foods, which fell down to 50%. Infrequent intake of vegetables was prevalent among 30% of the participants on follow-up. Now, this difference was statistically significant. While the prevalence of unhealthy dietary habits overall was noted to be 70% at the baseline, there was a marginal decrease to 68%. However, this difference also was not significant statistically. Risk factors pertaining to physical activity among adolescents, for example, usually not walking or cycling to school increased to 33% on follow-up compared to 30% at the baseline. However, there was a marginal decrease in prevalence of sitting activities from 15% at the baseline to 14%. Similarly, for inadequate other daily physical work, the prevalence decreased from 25% to 24%. However, the overall prevalence of inadequate physical activity increased to 51% from the baseline value of 48%. However, none of these differences were statistically significant. After completion of follow-up, 10% of the students were found to have reported the presence of family history.

It is important to note that while there is a statistical difference in the outcome variable (overweight and obesity) over time, such differences are mostly not there for the risk factors of interest. Although effect of the predictors on the outcome cannot be simply written off basing on only this disparity, it can be well understood that the cause of disparity is most likely hidden in the effect of the risk factors over time (i.e., the time interaction)

Predictors of overweight and obesity

Table 2 shows the GEE models done for different dietary risk factors and risk factors of physical inactivity. Female gender and older age group (i.e., >16 years of age) were at higher risk of developing

overweight and obesity. In the cumulative (overall) model, intake of fast showed highest risk (3.14, 95% CI: 1.96–4.85) in favor of development of overweight. The risk estimate for fast food intake causing overweight was also the highest among the girls (4.59, 95% CI: 1.80–10.74). Less fruits and vegetables consumptions were statistically linked with overweight and obesity. Those who had a regular intake of soft drinks were at 2.41 (95% CI: 1.51–3.87) times risk of getting overweight. In the GEE model for boys, older age did not have any statistically significant effect. However, similar to the cumulative model fruit and vegetables ingestion, soft drinks, and fast food, intake did have a statistically significant relationship. Among the boys, the maximum risk was observed with eating less vegetable (4.74, 95% CI: 1.94–11.79). In case of the girls, risk of older girls becoming overweight was 5.11 (95% CI: 1.81–14.68). While none of the variables related to physical activity were significant statistically in any of the models, inadequate daily work was observed to have statistically significant risk of 2.58 (95% CI: 1.21–5.65). Eating less vegetable was not statistically significant among girls. However, intake of soft drinks had a risk (4.50, 95% CI:

1.94–10.60) comparable to that of fast food intake.

Table 3 summarizes the effects of overall dietary habit and physical activity adjusting for gender age group of the respondents. In Table 3, the two-way interaction terms are incorporated to identify the significant interactions between the modifiable and non modifiable risk factors depicted in Table 3. Overall unhealthy dietary habit was found to contribute a risk of 8.72 (95% CI: 5.48–13.90), which was higher compared to risk contributed by inadequate physical activity (6.68, 95% CI: 3.82–10.93). Both these risks increase in boys and girls separately. The unhealthy dietary practices lead to

14.90 times (95% CI: 8.67–25.65) cumulative risk among the girls, which is higher compared to that in boys. On the other hand, inadequate physical activity among the boys leads to a very high cumulative risk of developing obesity. Along with the main effects, the interactions also appeared significant statistically in the mentioned models. However, this statistical significance implies the interrelationship of the modifiable and non modifiable risk factors.

**Table 1: Comparison of dietary practices, physical activity, and family history of the respondents at baseline and at follow-up after 6 months (n=200)**

Risk factors	Baseline, n (%)	After 6 months, n (%)	P
Most of the times going hungry at home	24 (12)	28(14)	0.517
Eating fruits less than once a day	100 (50)	104 (52)	0.331
Eating vegetables less than once a day	50 (25)	60(30)	0.042
Intake of soft drinks more than thrice a week	82 (46)	98 (49)	0.873
Intake of fast food more than thrice a week	108 (54)	100 (50)	0.084
Unhealthy dietary habits	140 (70)	136 (68)	0.433
Usually not walking or cycling to-and-from school	60 (30)	66(33)	0.341
≥4 h of sitting activity	30 (15)	28 (14)	0.790
Inadequate other daily physical work (Including outdoor sports)	50(25)	48 (24)	0.503
Inadequate physical activity (overall)	96(48)	102 (51)	0.698

**Table 2: GEE models done for different dietary risk factors and risk factors of physical inactivity**

Factors affecting development of overweight and obesity	Overall (n=200)			Female (n=120)		Male (n=80)	
	Risk ratio (95% CI)		P	Risk ratio (95% CI)	P	Risk ratio (95% CI)	P
Sex: Female	2.21 (1.51-3.77)		0.001	-	-	-	-
Age group: Older (>16 years)	2.77 (1.68-4.64)		<0.001	1.62 (0.91-3.08)	0.077	5.11 (1.81-14.68)	0.002
Family history	1.87 (0.68-4.66)		0.256	1.98 (0.47-8.43)	0.353	1.82 (0.51-7.51)	0.331
Usually not walking or cycling to and-from school	1.66 (0.95-2.72)		0.077	1.92 (0.82-4.33)	0.130	1.77 (0.98-3.83)	0.057
≥4 h of sitting activity	1.37 (0.65-2.61)		0.301	1.43 (0.59-3.47)	0.335	1.13 (0.33-3.33)	0.854
Inadequate other daily physical work (including outdoor sports)	1.81 (0.95-3.55)		0.078	2.38 (0.86-6.41)	0.093	2.58 (1.21-5.65)	0.023
Most of the times going hungry at home	1.42 (0.72-2.89)		0.331	1.35 (0.55-3.36)	0.614	2.51 (0.78-8.21)	0.111
Eating fruits less than once a day	2.41 (1.62-3.77)		<0.001	3.53 (1.97-6.28)	<0.001	3.15 (1.70-5.27)	<0.001
Eating vegetables less than once a day	1.97 (1.19-3.54)		0.020	4.74 (1.94-11.79)	0.001	1.28 (0.53-3.04)	0.324
Intake of soft drinks more than thrice a week	2.41 (1.51-3.87)		0.001	2.37 (1.31-4.11)	0.003	4.50 (1.94-10.60)	0.001
Intake of fast food more than thrice a week	3.14 (1.96-4.85)		<0.001	3.13 (1.74-5.44)	<0.001	4.59 (1.80-10.74)	<0.001
CI: Confidence interval							

**Table 3: the effects of overall dietary habit and physical activity adjusting for gender age group of the respondents**

Factors affecting development of overweight and obesity	Overall ( <i>n</i> =200)		Female ( <i>n</i> =120)		Male ( <i>n</i> =80)	
	Risk ratio (95% CI)	<i>P</i>	Risk ratio (95% CI)	<i>P</i>	Risk ratio (95% CI)	<i>P</i>
Sex: Female	7.56 (3.83-14.25)	<0.001	-	-	-	-
Age group: Older (>16-years)	9.65 (4.64-18.51)	<0.001	10.66 (5.63-21.46)	<0.001	20.44 (5.87-72.21)	<0.001
Overall physical activity Inadequate	6.68 (3.82-10.93)	<0.001	13.85 (6.67-28.56)	<0.001	8.58 (4.82-15.22)	<0.001
Overall dietary habit: Unhealthy	8.72 (5.48-13.90)	<0.001	10.77 (5.79-19.40)	<0.001	14.90 (8.67-25.65)	<0.001
Interactions						
Inadequate physical activity and unhealthy diet	0.38 (0.16-0.81)	0.017	0.22 (0.05-0.72)	0.012	0.13 (0.04-0.37)	<0.001
Female and inadequate physical activity	0.32 (0.14-0.89)	0.013	-	-	-	-
Female and unhealthy dietary habits	0.37 (0.16-0.71)	0.014	-	-	-	-
Older age and Inadequate physical activity	0.25 (0.11-0.63)	0.002	0.10 (0.03-0.43)	0.001	0.78 (0.16-5.17)	0.786
Older age and unhealthy dietary habits	0.22 (0.08-0.62)	0.002	0.22 (0.06-0.69)	0.011	0.13 (0.03-0.55)	0.008

## Discussion

In consonance with the findings of the other researchers[21,26], prevalence of obesity and overweight was observed to be on a rising note in the current study as well with a sharp rise of around 8% among the participants. Since overweight and obesity are itself time-varying dynamic condition, the difference observed is actually a net increase (newly developing overweight – those returning below overweight BMI category); therefore, this can be regarded as a “net incidence,” which is in fact a proxy marker for incidence of the morbidity under discussion. In a comparative study in West Bengal, Ghosh[22] found the prevalence of overweight and obesity to be higher in urban area. However, the proportions depicted in that study in the rural areas were very much comparable to the baseline findings of the current study. Craig *et al.*[27] found that in rural South Africa, the effect of female sex on development of obesity was very high. The findings were supported by the current study through the obtained risk estimates, which were indeed high. This was also the case in several of the India studies[21,25,26,28] and also consistent with NFHS-4 report[29]. Several authors studying the risk factors of obesity have concluded with behavioral modification, diet, and physical activity being their part[23,24,26,30] but were not able delineate the effect size or the relative risk of these behavioral factors. In the current study, by virtue of its longitudinal design, the risk estimates for different modifiable factors adjusting for the non-modifiable factors were obtained.

There is strong evidence of dietary practices being more rigidly related to overweight among the adolescent. Although inconsistent conceptually, the variables of physical activity did not show statistical significance individually in the primary model. However, the significance of cumulative effect was derived from the interaction model. It was observed that age

itself was a more important predictor of overweight and obesity among females than males. Among the dietary factors studied, fast food intake followed by soft drinks intake was the most vital risk factors identified. These are even more important in case of females. The cause may be that the girls tend to eat and drink these items more compared to boys in the rural area. However, less vegetable intake was more detrimental in case of boys, as observed in the study. The likely explanation for this lies within the fact of less consumption of vegetables by boys as compared to girls, with boys receiving more calorie and protein intensive diet. Goyal *et al.*[26] showed that the lifestyle factors have an enormous effect on overweight and obesity, which are similar across different socioeconomic groups. However, the invariance of effect across different groups was not studied currently; rather the cumulative or crude measure of effect was noted.

It is well understood that the risk factors of the NCDs itself form a spectrum with intricate interrelation. The current study attempted to capture the effect of two selected factors contributing to obesity adjusting for some non-modifiable factors. One of the drawbacks in the study however remains with the use of questionnaires, as conscious falsification by the respondents would always create a skewed result. Because sections of a class were selected, the study could have encountered selection bias at the initial phase. The current study despite being school-based, an individual-level longitudinal study was conducted thus overcoming the probable source of ecological fallacy. An interventional design with a higher power (larger sample size) will help to get a more precise result in future. The recommendations that emerged from the study were that healthy dietary practices and physical activity should be promoted to mitigate the risk of obesity. Increasing awareness among the girls regarding the ill-effects of junk foods

and soft drink is also needed. Since in the rural areas, still farming remains the dominant profession, adolescents should be encouraged to consume more fruits and vegetables; this, however, is more required for the male child. The teachers and the parents should be educated and motivated about behavioral change trainings of the adolescents. With the increase in overweight and obesity in such epidemic proportions, the regular school-based health checkups are a generic requirement.

### Conclusion

Strong evidence was generated of dietary practices being more rigidly related to overweight among the adolescents. Healthy dietary practices coupled with physical activity should be promoted to mitigate the risk of obesity.

### Reference

1. UNICEF, United Nations Children's Emergency Fund. The State of the World's Children: Adolescence an Age of Opportunity. New York, USA: United Nations Children's Emergency Fund; 2011.
2. Rampersaud GC, Pereira MA, Girard BL, Adams J, Metz J. Breakfast habits, nutritional status, body weight, and academic performance in children and adolescents. *J Am Diet Assoc.* 2005; 105: 743-760.
3. Mushtaq MU, Gull S, Shahid U, et al. Family-based factors associated with overweight and obesity among Pakistani primary school children. *BMC Pediatrics.* 2011; 11: 114-122.
4. Khuwaja AK, Khawaja S, Motwani K, et al. Preventable lifestyle risk factors for noncommunicable diseases in the Pakistan adolescents schools study 1 (PASS-1). *J Prev Med Public Health.* 2011; 44: 210-217.
5. Jafar TH, Qadri Z, Islam M, Hatcher J, Bhutta ZA, Chaturvedi N. Rise in childhood obesity with persistently high rates of undernutrition among urban school-aged IndoAsian children. *Arch Dis Child.* 2007; 93:373-378.
6. Galloway R, Dusch E, Elder L, et al. Women's perceptions of iron deficiency and anemia prevention and control in eight developing countries. *Soc Sci Med.* 2002; 55: 529-544. Web site. <http://www.ncbi.nlm.nih.gov/pubmed/12188461>. Accessed July 24, 2020
7. Ferreiro F, Seoane G, Senra C. Toward understanding the role of body dissatisfaction in the gender differences in depressive symptoms and disordered eating: A longitudinal study during adolescence. *J Adolesc.* 2014; 37: 73-84.
8. Qidwai W, Ishaque S, Shah S, Rahim M. Adolescent lifestyle and behaviour: A survey from a developing country. *Plos One.* 2010; 5: e12914.
9. Savage GS, Ball K, Worsley A, Crawford D. Food intake patterns among Australian adolescents. *Asia Pac J Clin Nutr.* 2007; 16: 738-747.
10. Ogechi UP, Akhakhia OI, Ugwunna UA. Nutritional status and energy intake of adolescents in Umuahia urban, Nigeria. *Pak J Nutr.* 2007; 6: 641-646.
11. WHO, World Health Organization. Nutrition in Adolescents: Issues and Challenges for Health Sector. Geneva, Switzerland: World Health Organization; 2005.
12. Campbell K, Peebles R. Eating disorders in children and adolescents: State of the art review. *Pediatr.* 2014; 134: 582-594.
13. WHO. Global School-based Student Health Survey. Available from: <http://www.who.int/chp/gshs/bangladesh/en/>. [Last accessed on 2020 Jan 11].
14. NCDs. The STEPS Instrument and Support Materials. Available from: <http://www.who.int/ncds/surveillance/steps/instrument/en/>. [Last accessed on 2020 Sep 26].

15. Cronbach LJ. Coefficient alpha and the internal structure of tests. *Psychometrika* 1951; 16:297.
16. Tavakol M, Dennick R. Making sense of Cronbach's alpha. *Int J Med Educ* 2011; 2:53-5.
17. World Health Organization. Growth Reference – BMI-for-Age Charts and Tables. WHO | BMI-for-age (5-19 years). Available from: [https://www.who.int/growthref/who2007\\_bmi\\_for\\_age/en/](https://www.who.int/growthref/who2007_bmi_for_age/en/). [Last accessed on 2020 Sep 27].
18. Zeger SL, Liang KY. Longitudinal data analysis for discrete and continuous outcomes. *Biometrics* 1986; 42:121-30.
19. Zeger SL, Liang KY. An overview of methods for the analysis of longitudinal data. *Stat Med* 1992; 11:1825-39.
20. Prasad Social Classification Update. Prasad Social Classification Scale Update. Available from: <http://prasadscaleupdate.weebly.com/real.html>. [Last accessed on 2020 Sep 27].
21. Ranjani H, Mehreen TS, Pradeepa R, Anjana RM, Garg R, Anand K, *et al.* Epidemiology of childhood overweight & obesity in India: A systematic review. *Indian J Med Res* 2016; 143:160-74.
22. Ghosh A. Rural-urban comparison in prevalence of overweight and obesity among children and adolescents of Asian Indian origin. *Asia Pac J Public Health* 2011; 23:928-35.
23. Meharda B, Sharma SK, Singhal G, Kumar LD. Overweight and obesity: A rising problem in India. *Int J Community Med Public Health* 2017; 4:4548.
24. Urmila K, Divya K, Sudakaran, Nambiar M. Prevalence and risk factors of obesity among higher secondary school students in urban and rural schools of North Kerala. *Int J Contemp Pediatr* 2017; 4:1851.
25. Subramanyam V, Jayashree R, Rafi M. Prevalence of overweight and obesity in affluent adolescent girls in Chennai in 1981 and 1998. *Indian Pediatr* 2003; 40:775-9.
26. Goyal RK, Shah VN, Saboo BD, Phatak SR, Shah NN, Gohel MC, *et al.* Prevalence of overweight and obesity in Indian adolescent school going children: Its relationship with socioeconomic status and associated lifestyle factors. *J Assoc Physicians India* 2010; 58:151-8.
27. Craig E, Reilly JJ, Bland R. Risk factors for overweight and overfatness in rural South African children and adolescents. *J Public Health (Oxf)* 2016; 38:24-33.
28. Mittal PC, Srivastava S. Diet, nutritional status and food related traditions of Oraon tribes of new mal (West Bengal), India. *Rural Remote Health* 2006; 6:385.
29. State Fact Sheet West Bengal. In: National Family Health Survey – 4. Available from: [http://rchiips.org/NFHS/pdf/NFHS4/WB\\_FactSheet.pdf](http://rchiips.org/NFHS/pdf/NFHS4/WB_FactSheet.pdf). [Last accessed on 2020 Jul 24].
30. Panda SC. Overweight and obesity and lifestyle of urban adolescent school children of Eastern state of India. *Int J Res Med Sci* 2017; 5:4770.